CHEMICAL CONTROL OF WEEDS IN OLIVE GROVES

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Weeds were effectively controlled with the pre-emergent herbicide treatments diuron + simazine, napropamide, napropamide + simazine, oxyfluorfen, propyzamide + simazine and terbutryn + simazine. Post-emergence, the mixture diquat + paraquat also gave satisfactory results. None of the treatments produced visible adverse effects on mature trees. The same herbicide treatments administered to very young olive trees grown in pots had no effect on stem girth increase and, as in mature trees, produced no visible symptoms of any kind. Economic evaluation of the treatments showed that many of them are less costly than cultivation.

INTRODUCTION

Olive trees have a strong competitive ability against weeds. Yet the latter take up large amounts of available moisture and nutrients. In rainfed olive groves in years of drought, the depletion of moisture due to weeds may prove critical to the production of an economic crop. Also, weeds shelter rodents and other pests and they interfere with orchard operations leading to increased production costs. In particular, they impede harvesting, especially the gathering of dropped fruit. According to Pollastro (1977), clean soil may raise labour efficiency from about 50 kg to as much as 200 kg/day. It is, therefore, necessary to manage weeds in a way that will minimize their harmful effects.

Olive growers commonly cultivate their groves, usually with a rotavator, in order to kill weeds. Cultivations, however, have only a temporary effect on weeds, while perennial species may even be favoured through the cutting up and scattering of their propagules. Cultivation also damages superficial roots and tree trunks and may increase soil erosion. On the other hand bare soil conditions created by soil acting herbicides often result in encrustation and consequent reduction in permeability (Rom, 1972). Other research, however, claims that chemical weed control conserves moisture vis-a-vis cultivation (Michelson and Lord, 1965).

Growers occasionally use a contact herbicide, such as paraquat, to kill existing weeds, especially soon before harvest, in order to facilitate gathering of the fruit. Pre-emergence herbicides which keep the soil clean are more helpful in this respect than contact herbicides (Civantos and Gomez-Uribani, 1978). Herbicide use can be adopted to local soil conditions and weed complexes. In olive groves several herbicides have given satisfactory results in other countries (Fernandez and Velasco, 1978; Arenstein, 1980). They also encourage root growth (Bini and Ghisolfi, 1986).

Olives are an important crop in Cyprus, occupying an area of about 3,200 hectares. Control of weeds is an important cost item estimated at £90 per hectare. The objectives of this study were to find suitable herbicides for olive groves and to compare the cost of their use to that of cultivations.
MATERIALS AND METHODS

Trials were carried out both in the field in mature olive groves and in pots with young trees. The treatments were tested in randomized complete blocks replicated three times.

In the field trial, plot size was 13.6x8 m, comprising one whole and two "half trees". The trees, which were of the local variety, were over 30 years old.

The grove was rotavated prior to initial herbicide application in January 1986. Thereafter pre-emergence herbicides were applied every year in early winter before weed germination, while the only post-emergence treatment was applied when enough weeds had germinated to almost cover the ground. In years of satisfactory rainfall a second post-emergence application was made to control a later flush of weeds. Herbicides were applied with a knapsack sprayer fitted with a flat-fan nozzle. Spray volume was 500 l/ha. The treatments chosen were mostly mixtures of herbicides because experience with other perennial crops (Americanos, 1975, 1982) had shown that such mixtures controlled a wider spectrum of weeds than did straight herbicides. Two and four months after the application of pre-emergence treatments, weeds were collected from 2 m² in each plot using a 0.1 m² quadrat thrown at random. Weeds thus collected were oven dried and their weight was recorded. Weed species in each treatment were also recorded. The grove had an infestation of the winter perennial weed *Oxalis pes-caprae* L., which was very dense in a strip of about one metre on the tree rows where the soil was under heavy shade. A visual estimation of the effect of herbicides on this species was made in February 1988, two months after application, when *Oxalis* was already growing well.

In the pot trials same-year budded trees of the local variety and of the variety Picual were planted in pots of 26 cm diameter, in November 1988. In early December, stem girth was measured at 2 cm above ground and subsequently herbicides were applied at the same rates as in the field trials, in 25 ml solution per pot. Herbicides were re-applied in June 1989 and again in December 1989. One year after the initial application of herbicides, stem girth at the same point as before was again measured. The data on girth increase were subjected to covariance analysis to test the effect of herbicide treatments. Throughout the period December 1988-April 1990, the trees were periodically visually examined for symptoms of toxicity such as stunting, leaf drop, small leaf size and chlorosis or necrosis of leaves and shoot tips.

RESULTS AND DISCUSSION

Effect on weeds

All pre-emergence herbicide treatments effectively controlled weeds for up to four months after application (Table 1). There were differences among treatments at this time, which were not evident two months after application. The post-emergence mixture of diquat + paraquat, although better than the cultivated control after a second application, was inferior to the pre-emergence treatment (Table 1). The most effective treatment four months after application were the high rate of the mixture diuron + simazine, both rates of the mixture napropamide simazine and both rates of oxyfluorfen. The latter is at variance with the findings of Pastor et al. (1983) who reported oxyfluorfen as less effective than several other herbicides tested, including diuron and simazine.

*Oxalis pes-caprae* L., which grew abundantly along the tree rows where there was plenty of shade, was unaffected by most herbicides. Observations made at the beginning of March 1986, two months after herbicide application indicated that both rates of the mixture diuron + simazine and of oxyfluorfen had an important effect on this weed. The effect of oxyfluorfen was more pronounced than that of the mixture. Diquat + paraquat also had a useful effect. A visual estimation of ground cover by *Oxalis* made in February 1988, three months after application, bore out the 1986 observations (Table 1). Oxyfluorfen was the most effective herbicide against this perennial weed. This is in agreement with the recommendations of Paspatis (1987) for the control of *O. pes-caprae* L. in vineyards.

Effect on trees

None of the herbicides caused any symp-
Table 1. Effect of herbicides on the dry weight of weeds in an olive grove and on girth increase in young olive trees

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Rate (g a.i./ha)</th>
<th>Dry weed weight at 2 mos</th>
<th>Dry weed weight at 4 mos</th>
<th>Oxalis cover</th>
<th>Girth Increase 12 months after application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diuron+Simazine</td>
<td>985 + 475</td>
<td>2.4cd</td>
<td>149.7bc</td>
<td>24</td>
<td>6.5 Loc, 9.6 Picual</td>
</tr>
<tr>
<td></td>
<td>1235 + 600</td>
<td>0.5d</td>
<td>21.2cd</td>
<td>28</td>
<td>10.9 Loc, 11.1 Picual</td>
</tr>
<tr>
<td>Napropamide</td>
<td>4480</td>
<td>2.6cd</td>
<td>24.3cd</td>
<td>88</td>
<td>9.3 Loc, 14.7 Picual</td>
</tr>
<tr>
<td></td>
<td>6725</td>
<td>8.5cd</td>
<td>89.1cd</td>
<td>74</td>
<td>6.2 Loc, 11.8 Picual</td>
</tr>
<tr>
<td>Napropamide+Simazine</td>
<td>1500 + 750</td>
<td>9.1b</td>
<td>3.4d</td>
<td>92</td>
<td>6.5 Loc, 12.0 Picual</td>
</tr>
<tr>
<td></td>
<td>2000 + 1000</td>
<td>5.8bc</td>
<td>0.1d</td>
<td>83</td>
<td>11.0 Loc, 11.9 Picual</td>
</tr>
<tr>
<td>Oxyfluorfen</td>
<td>1500</td>
<td>123.6bcd</td>
<td>28</td>
<td>10.9 Loc, 11.2 Picual</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2250</td>
<td>21.7cd</td>
<td>11</td>
<td>9.9 Loc, 17.4 Picual</td>
<td></td>
</tr>
<tr>
<td>Propyzamide+Simazine</td>
<td>900 + 750</td>
<td>5.3cd</td>
<td>187.4cd</td>
<td>97</td>
<td>9.0 Loc, 10.2 Picual</td>
</tr>
<tr>
<td></td>
<td>1200 + 1000</td>
<td>1.5cd</td>
<td>123.6bcd</td>
<td>79</td>
<td>9.2 Loc, 16.5 Picual</td>
</tr>
<tr>
<td>Terbutryn+Simazine</td>
<td>750 + 750</td>
<td>5.5cd</td>
<td>126.8bcd</td>
<td>97</td>
<td>8.1 Loc, 11.2 Picual</td>
</tr>
<tr>
<td></td>
<td>1000 + 1000</td>
<td>5.4cd</td>
<td>100.7bcd</td>
<td>98</td>
<td>8.6 Loc, 11.2 Picual</td>
</tr>
<tr>
<td>Diquat+Paraquat</td>
<td>200 + 200</td>
<td>2.8cd</td>
<td>338.9b</td>
<td>21</td>
<td>6.0 Loc, 10.6 Picual</td>
</tr>
<tr>
<td>Cultivated control</td>
<td>34.0a</td>
<td>401.7a</td>
<td>90</td>
<td>6.7 Loc, 10.9 Picual</td>
<td></td>
</tr>
</tbody>
</table>

Means followed by a different letter are significantly different at P<0.05.
Data were transformed to (X+0.5)·5 and covariance analysis was used.

toms of toxicity on the trees at any time during the four years of the trial. The same holds true for the very young trees grown in pots and for both varieties, i.e. Local and Picual. Although young trees were treated within a space of twelve months three times with the herbicides they exhibited no symptoms of toxicity.

Effect on girth increase
Measurements of stem diameter 2 cm above ground at the onset of treatment with herbicides and again one year later showed that increase in girth was not affected by herbicides in either variety. Prado et al. (1984) working with five olive varieties in Spain reported that fluorescence tests on whole leaves for the inhibition of photosynthesis failed to reveal any differences between varieties. The lack of effect on girth increase coupled with the absence of any symptoms on either the young or the mature trees leads to the conclusion that the herbicide treatments tested can safely be used in olive groves.

The cost of the various treatments is shown in Table 2.

The cost of herbicide treatments includes application cost of £30/ha for sprayable herbicides and £23/ha for granulars.

Although several herbicide treatments appear to be more expensive than cultivation, the drawbacks of that method of weed control must be taken into consideration as must also the fact that herbicides encourage root growth (Bini and Ghisolfi, 1986). The choice of herbicides depends primarily on the prevailing weed species. Economic considerations assume importance when the same target species are controlled by more than one herbicide. It is important to bear in mind that repeated use of the same herbicide will encourage resistant species to spread and become dominant (Americanos, 1982).
To avoid such eventuality, suitable herbicides must be applied alternately. Many perennials with strong regenerative powers such as *Cynodon dactylon* (L.) Pers. and *Convolvulus* spp. escaped the effect of all herbicides tested in the present work. Their numbers in the experimental grove were small, but the removal of competition from annual species will encourage their spread. In such cases it is important to take remedial steps early before these weeds overtake the orchard. This is achieved by supplementing the residuals with suitable post-emergence herbicides (Americanos, 1978).

**REFERENCES**


